

EM-RFO--KHLL-371OPS-2003-0011 FINAL

371 Operations
(Name of Facility)

Plutonium Processing and Handling
(Facility Function)

Rocky Flats Env. Technology Site Kaiser-Hill Company, L.L.C.
(Site) (Contractor)

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1. Occurrence Report Number: EM-RFO--KHLL-371OPS-2003-0011

During D&D Operations Combustibles In Glovebox Ignited Causing A Fire Which Was Contained Inside of The Glovebox

2. Report Type and Date: FINAL

Date Time

Notification: 05/07/2003 13:54 (ETZ)

Initial Update: 05/08/2003 08:11 (ETZ)

Latest Update: 05/03/2004 12:21 (ETZ)

Final: 12/16/2004 12:44 (ETZ)

3. Occurrence Category: Unusual

4. Number of Occurrences: 1 **Original OR:**

5. Division or Project: Kaiser-Hill Company LLC

6. Secretarial Office: EM - Environmental Management

7. System, Bldg., or Equipment: Building 371, Room 2325, Glovebox 8

8. UCNI?: No

9. Plant Area: 371 Project

10. Date and Time Discovered: 05/06/2003 09:08 (MTZ)

11. Date and Time Categorized: 05/06/2003 10:40 (MTZ)

12. DOE HQ OC Notification:

Date	Time	Person Notified	Organization
05/06/2003	11:08 (MTZ)	Thomas Yates	DOE/HQ

13. Other Notifications:

Date	Time	Person Notified	Organization
05/06/2003	11:02 (MTZ)	Frank Haley	SSOC
05/06/2003	11:04 (MTZ)	Ed Kray	CDH&E
05/06/2003	14:02 (MTZ)	Joe Sondag	DOE/RFFO

14. Subject or Title of Occurrence:

During D&D Operations Combustibles In Glovebox Ignited Causing A Fire Which Was Contained Inside of The Glovebox

15. Nature of Occurrence:

01) Facility Condition
B. Fires/Explosions
04) Personnel Radiological Protection
B. Personnel Contamination

16. Description of Occurrence:

Event Description:

On May 6, 2003, D&D activities were taking place in room 2325 in Building 371. Specific actions included cutting sheet metal panels from glovebox 8 to provide an airflow path in an attempt to provide ventilation into the glovebox to reduce airborne levels of plutonium during subsequent clean out and size reduction of the glovebox. Workers noted smoke and evidence of a fire inside the glovebox structure, and took actions in an attempt to control the situation. The workers discharged a number of portable fire extinguishers into the glovebox, only to have the fire re-ignite. Concurrent with these actions, the job supervisor notified the facility Configuration Control Authority (CCA) of the event, who contacted the Fire Department, initiating their response. Further attempts to control the situation were initiated by the workers until the Fire Department arrived on scene and, using water, extinguished the fire and stabilized the situation. Actual

damage to the glovebox and other equipment was minimal, however four of the fire fighters received skin contamination as a result of the fire fighting efforts. Because of the use of respirators, they did not receive any radioactive material uptake or significant dose (maximum of 20 mrem). Bioassay analysis of other potentially affected building personnel did not show any significant personnel contamination or radioactive material uptakes.

Background

Glovebox 8 was originally intended to function as an elevator to move items between gloveboxes in room 2325 and gloveboxes in room 3701, directly above. It was used for a brief period of time in the mid-1980s. The elevator was abandoned, and the penetration between the two floors sealed with steel and concrete approximately 15 years ago. Glovebox 8 was approximately four feet square, and extended from the floor to the ceiling in room 2325. It had very few windows, and only a few glove ports for maintenance activities. Two other gloveboxes, 9 and 10, originally attached to two sides of glovebox 8, had been removed prior to this event, leaving two small transition sections sealed with sheet metal on the outside. Guillotine doors between glovebox 8 and gloveboxes 9 and 10 remained in these transition sections. Located in the lower section of the glovebox was a tray or plate that formed the floor of the elevator. This plate was not at the bottom of the glovebox, but rather was elevated from the floor of the glovebox by about three feet. After the fire, it was determined that legacy combustible material had been left under and on the plate, probably during the renovation activities mentioned earlier. Additionally, more recent combustibles (possibly including wipes used in decontamination activities of GB 9 and 10) were found, as well as a greenish powdery residue, a tarp, other miscellaneous items and five 4-liter containers filled with a caustic liquid.

A Soft-Sided Containment (SSC) contamination control tent had been built around glovebox 8 to facilitate size reduction. The tent was constructed of fire retardant plastic, and ran from floor to ceiling around the box. Scaffolds were erected around the glovebox inside the SSC to provide safe access for the workers during the D&D activities. Three HEPA filtered air-movers provided ventilation for the tent, and a fourth air-mover was connected to the bottom of glovebox 8. PremAire supplied air breathing equipment was in use during the work activities the day of the fire. This was the first supplied air entry into the tent. The purpose of the entry was to cut a hole near the top of the box to provide a ventilation flow path for subsequent D&D activities on the glovebox. The cut was to be made by a nibbler, which is not considered hot work under Site criteria. Work in this particular room had been ongoing since June 2002. In October 2002, a different work crew from the original crew was assigned this work, and was the crew performing activities on the day of the fire.

On the morning of May 6, 2003 two workers donned PremAire supplied air suits and entered the containment tent. They then used a nibbler to cut a hole

approximately three feet by four feet, allowing the cut pieces to fall inside the box. Immediately following the last cut, at approximately 0904, one worker noticed what he originally believed to be dust rising from the bottom of the box. The second worker looked, and the two concluded it to be smoke, not dust. The workers notified the job supervisor of the fire condition. Interviews conducted related that the supervisor did not immediately report the fire condition. There was a delay of reporting 0905-0908, causing a delay between the CCA being informed and relay of the information to the Fire Department. When the CCA received and relayed this request to the Site Fire Department (the Fire Department logged the call at 0911), and made a building announcement to conduct a controlled evacuation of the sub-basement and basement areas of Building 371. The workers in the tent were notified that the Fire Department was en-route.

During this time, the workers were able to see flames near the bottom of the box. They initially attempted to extinguish the fire by pouring a small amount of water (<4 liters) which was previously approved into the glovebox onto the burning debris through the hole they had cut. They descended from the scaffolding, and removed a plate from the bottom of the box to gain access to the area of the fire. They removed the plate, and used a fire extinguisher to extinguish the flames. The CCA was notified that the flames were extinguished, but that the combustibles were continuing to smolder. Shortly after this, the workers in the tent reported that the fire "reflashed" and had begun to burn again. This was reported to the CCA. The workers again used fire extinguishers to attempt to suppress the flames. During the fact finding meeting, workers explained that the fire appeared to be burning underneath the debris they could see inside the box. Using a scaffold pole, one of the workers lifted the top layer of debris so that the second worker could attempt to direct a fire extinguisher directly on the burning items. The workers reported the flames to be blue in color, rather than yellow flames they would have expected from burning trash. The workers in the tent reported using eight to ten fire extinguishers while waiting for the fire department to arrive. During the fact finding meeting, both workers stated they felt comfortable remaining in the tent while waiting for the fire department to arrive, and did not feel they were at personal risk. They stated they had been trained on fire extinguisher use, and believed they were successful at containing the fire pending fire department response.

The Site Fire Department arrived at the building at 0914, was briefed by the CCA on the situation, and then proceeded to room 2325. CCA logbook and fire dispatch entries indicate that after the notification from the supervisor to the CCA, the Fire Department was on scene in room 2325 within 11 minutes. However, based on the report by the job supervisor that this was a "small" fire, and later that the fire was extinguished, the Fire Department did not take all of their fire fighting equipment to the scene. The BEST team had to bring additional items from the step off pad to the scene so that the Fire Department could effectively control the fire.

As the Fire Department arrived at the room, the workers were doffing their PPE and exiting from the tent. The first worker performed an emergency egress, and the second worker doffed normally at the entrance to the tent. Both workers successfully doffed with no contamination. Fire Department personnel entered the tent in SCBA, and attacked the fire with fire extinguishers. A total of sixteen fire extinguishers were subsequently determined to have been used, including those used initially by the workers in the tent. Confirmation from the Building 371 ESH&Q Manager that there was no criticality risk was received at 0946, and the fire fighters charged hoses and sprayed water directly in the glovebox to fully extinguish the smoldering debris. (The box contained 427 grams Pu at 95% confidence). At 0958, the Fire Department reported that the fire had been fully extinguished.

Four firefighters received skin contamination as a result of the response to the fire in room 2325, glovebox 8. The "bunker gear" that the fire fighters were wearing are much more difficult to doff than traditional Anti-C clothing. Contamination was discovered on the outside of fire fighters' gear and during the doffing process of removing the bulky gear, which included Self Contained Breathing Apparatus (SCBA), some contamination was inadvertently spread to exposed skin. One individual had skin contamination levels up to 12,000-dpm/100 cm² on his neck, torso, arms and legs. A second individual had skin contamination levels up to 10,000-dpm/100 cm² on his neck, arms and legs. A third individual had skin contamination levels up to 3,600-dpm/100 cm² on his hands. A fourth individual had skin contamination levels up to 1,800-dpm/100 cm² on his hands. All four firefighters were successfully decontaminated and were requested to submit bioassay samples as a precaution. The individual with the greatest contamination levels was sent to Occupational Medicine for final decontamination and the other three were decontaminated in the facility.

During the fact finding meeting, the D&D workers stated that they did not believe heat from the nibbler was the initiator for the fire. Fire Protection Engineering concurred with this opinion, but the likely cause for the fire was not determined during the fact finding meeting.

-Timeline of the Event

0700 - Work is initiated for the day in room 2335 0832 - First worker on Breathing Air 0849 - Second worker on Breathing Air 0850 - Breathing Air work is initiated inside the SSC 0854 - Nibbling Operations commenced 0900 (approx.) - CCA notified of burning smell in the basement area by another work crew, SOE dispatched to investigate 0904-0908 - Crew discovered a small fire in the glovebox and attempted to extinguish. 0908 - Supervisor reported a fire in room 2325 to the B371 CCA 0908 - Partial evacuation of facility ordered by the CCA 0911 - Fire Department logged call from CCA for fire response to Room 2325 0914 - Fire Department personnel arrived at the facility 0916 - Fire first believed

to extinguished by facility personnel 0920 - Fire re-flashed 0920 - Fire Department arrives in Room 2325 0920 - (approx.) - Workers exit tent 0935 - Operations in the facility suspended 0936 - System 2 HVAC configured to emergency dump mode 0938 - System 1 HVAC configured to emergency dump mode. Room 2325 reported to be positively pressurized between 0938 and 1000 0946 - CSO / ESH&Q approves the use of water to fight fire 0949 - Fire hoses charged, facility flow (bells) alarm 0951 - CCA confirms flow alarm attributed to fire hose charging 0954 - LSDW building announcement made - updating situation 0955 - Room 3513 MSTs leave area due to smelling smoke in room 0958 - Fire Department reported that the fire was fully extinguished; response personnel accountability complete 0958 - Initial air samples from room determined to be 15,000 DAC in room 2325; basement posted as ARA 1000 - HVAC systems configured to normal operation 1000 - Personnel at scene verify room 2325 was under negative ventilation 1002 - Facility personnel accountability complete 1005 - Update briefing conducted at Incident Command 1015 - Evacuated personnel allowed to re-enter facility; excluded from MAA 1020 - Room 3341 MST allowed to leave station 1025 - Request from scene to secure Breathing Air system 1028 - Report of broken (cut and run) Breathing Air hoses in room 2325 1030 - Breathing Air system secured; BA system valve 13 shut 1032 - Radiological surveys indicated no contamination in corridor outside room 2325 1034 - Radiological surveys indicated no contamination in stairwells 1,2 and 3 1035 - All Fire Department personnel out of SSC 1100 - Incident Command terminated 1120 - B371 MAA main floor released for NMC inventory purposes 1200 - Odor complaints in Room 3701 1330 - B371 MAA main floor de-posed from Airborne Radioactivity Area 1350 - NMC completes inventory and MST is re-established 1410 - Security lock down of the facility is lifted 1430 -1500 (approx.) - Facility Industrial Hygiene personnel initiate air sampling

17. Operating Conditions of Facility at Time of Occurrence:

Normal Operations

18. Activity Category:

11 - Facility Decontamination/Decommissioning

19. Immediate Actions Taken and Results:

The Plant Fire Department responded, the facility was evacuated. Personnel were successfully decontaminated.

20. Direct Cause:

7) External Phenomena
C. External Fire or Explosion

21. Contributing Cause(s):

- 3) Personnel Error
- C. Communication Problem

22. Root Cause:

- 6) Management Problem
- B. Work Organization/Planning Deficiency

23. Description of Cause:

Analysis and Causation: An analysis of the information that was gathered during this investigation revealed that the following programmatic causes and vulnerabilities might have led to the initiation of the fire. This report also identifies two issues or weaknesses in the response to the fire. This report does not describe the physical cause of the fire, which was investigated by the RFETS Fire Department as well as a contracted fire investigator. Based on the Fire Investigation Report performed by Hughes Associates Inc., the most likely cause of the fire was impact ignition of nitric acid degraded leaded rubber gloves by cutout sections that fell into area of fire origin.

- Inadequate combustible control surveillances contributed to the fire, since none of the glovebox surveillances indicated (or at least documented) that there was a portion of the glovebox that could not be viewed during normal inspections. A weakness in the combustible control surveillance procedure may have contributed to this lack of detailed inspection. Instructions contained in PRO-1638-FIRE-CTL-371, Building 371/374 Combustible Control, direct the Fire Safety Officer (FSO) to inspect "each non-operating" and "each operating" glovebox in the facility. A number of gloveboxes in the facility were not inspected for a variety of reasons, including being located in an infrequently occupied area or are located in a High Radiation / High Contamination Area. Because the AC 5.4.1 Combustible Material Controls Bases in the B371/374 Basis for Interim Operations (BIO) allow this condition, it is not considered an Authorization Basis violation, however documentation of these exceptions was not recorded on the Compliance Tracking Forms. By indicating that no deficient conditions were identified during the surveillance implies that each and every glovebox is being inspected, when in fact this was not true.

- Inadequate hazard analysis based on incorrect implementation of Work Package type. A Standard Work Package (SWP) was used instead of a Type 1 work package. SWPs are used when the work is repetitive, hazards are well identified, and no unique or special instructions are required to perform the activity. The Decontamination and Decommissioning (D&D) of glovebox 8 required special instructions because of the unique configuration of the glovebox and the hazards were not well defined considering the unknown amount of combustibles under the elevator plate. Because the SWP was used in this case,

the hazards were not adequately identified because of an assumption that walkdowns for SWPs were less formal and fewer disciplines need typically participate in the walkdown portion of the hazard analysis. With fewer personnel participating, some of the hazards were apparently not well identified.

- Combustible materials were left in the glovebox without appropriate characterization, analysis, or approval and contrary to established procedures. Although some of the combustible materials were legacy material from the time when the glovebox was closed, post-fire clean out revealed that some of the combustibles were more recent, on the order of months old; not years to decades. Evidence indicates that rags accumulated inside the glovebox during decontamination efforts in adjoining gloveboxes. The cerium decontamination procedure, PRO-1470-DECON-371/374, Chemical Decontamination Of Equipment or Gloveboxes Contaminated With Plutonium, Revision 0, used prior to the fire requires combustibles that have been used during the process are treated (neutralized) and removed from the glovebox. This procedure was vague as to when to actually bag out the combustibles, however the intent was that they were to be removed at the end of decontamination efforts or before the quantity of the wipes met the definition of a fuel package. Although the physical cause of the fire has yet to be determined, un-neutralized cerium nitrate soaked wipes are considered combustible and evaluation of the waste from the glovebox removal showed combusted wipes consistent with those used in cerium nitrate decontamination.

- Ineffective Communication may have contributed to a delay in extinguishing the fire. Based on the report by the job supervisor that this was a "small" fire, and later that the fire was extinguished; the Fire Department did not take all of their fire fighting equipment to the scene. The BEST team had to bring additional items, including hose reels, from the step off pad to the scene so that the Fire Department could effectively control the fire. The Job Supervisor failed to use a fire phone to report the fire and instead used his radio to report the event. The supervisor did not immediately report the fire condition to the CCA. Interviews conducted related that the supervisor did not immediately report the fire condition. There was a delay of reporting between 0904-0908 causing a delay between the CCA being notified and the relay of information to the Fire Department. This contributed to a delay and interpretation that this event was not serious. When the CCA received and relayed this request to the Site Fire Department (the Fire Department logged the call at 0911), and made a building announcement to conduct a controlled evacuation of the sub-basement and basement areas of Building 371.

- Inappropriate response to the fire put D&D workers in jeopardy and was contradictory to site procedures and training. As the fire grew, the crew took additional steps to control the fire in conflict with the Site Hands-on Fire Extinguisher training, which does not allow the use of fire extinguishers when in PremAire PPE. Actions included removing a cover, stirring the combustible

materials and using approximately eight to ten fire extinguishers, all the while in PremAire (breathing air) suits. Although the workers believed that their actions were within their level of training and expertise, they did not recognize the danger they were in during the event, and did not evacuate in a timely manner.

-Investigation Findings: Several procedure noncompliances or implementation concerns were discovered during the course of this investigation. The more significant issues are described below:

1. The work planning process was less than adequate to address the unique hazards of glovebox 8.
2. The Job Hazard Analysis used to conduct this work was less than adequate to identify hazards and controls for work activities in glovebox 8.
3. Work was initiated on the glovebox with lack of understanding and knowledge of the conditions inside the glovebox. There was also a failure to utilize institutional knowledge available at the Site prior to intrusive work in glovebox 8.
4. The Combustible Control procedure was not adequately implemented to identify and control the quantity and nature of combustible materials inside glovebox 8.
5. Used decontamination rags were present in glovebox 8. This represented a procedural non-compliance for failure to remove the wipes from the glovebox after use.

Three procedure non-compliances were identified in the investigation but were considered inconsequential to the cause of the fire:

1. A procedural violation occurred when Cerium Nitrate decontamination solutions were mixed inside the glovebox prior to use.
2. The work package had pen and ink changes that were not correctly approved.
3. The work package documented a change in the Responsible Manager at least 5 times without appropriate documentation required by the IWCP manual.

Issues that were identified as problems with the response to the fire:

1. D&D personnel inappropriately responded to the fire by using at least 8 fire extinguishers as well as taking other actions (removing a cover plate from the glovebox, stirring the combustible materials) that were not in accordance with site procedure or training.
2. Communications to the firefighters from CCA that the fire had been extinguished caused delay in the fire fighters response.
3. Building evacuations were not well performed. Incident Command did not immediately evacuate the facility as required by the Emergency Response Procedure (i.e. emergency levels, fire response checklist) and as the facility has previously trained.
4. Air sampling to determine the presence of toxic materials was not initiated until a number of hours after the event and after personnel were authorized to re-enter the facility. The results of this testing were not formalized.

Although the physical cause of the fire has not yet been determined, B371 Management has implemented the following additional corrective action:

1. Procedure PRO-1470-DECON-371/374, Chemical Decontamination of Equipment or Gloveboxes Contaminated with Plutonium and PRO-1638-FIRE CTRL-371, Building 371/374 Combustible Control were revised to incorporate additional controls for the use of cerium nitrate solutions and the verification that un-neutralized cerium nitrate soaked materials are not left unattended.

-Methodology: Cause Analysis Methodology: The Phoenix Method of causal analysis was utilized to complete this assessment. Barrier analysis was the primary cause analysis method however, other cause analysis tools were also used to a lesser extent. Information was gathered through attendance at the fact-finding meetings, analysis of the specific work scope, documentation, and personnel interviews with individuals associated with this event and the Kaiser Hill Team "Investigation Surrounding the Fire in Glovebox 8 Building 371". Causal factors were grouped in Vulnerabilities, Triggers, Exacerbating and Mitigating issues. Finally, generic implications and recommendations were identified and will be presented for consideration.

- Significance and Consequences

Significance: Although there was a fire in a glovebox in the building that did include radioactive material, the building's authorization basis analyzed and anticipated that fires would occur in the building. Controls were put in place to limit the quantity of combustible materials so that a large fire could not occur. This fire was not considered large because it did not result in any release outside the building or extend beyond the interior of the glovebox. The containment tent (SSC) that enclosed the glovebox did not burn because the fire did not escape the confines of the glovebox and because the tent was constructed from fire retardant materials. Because of the way the ventilation system is designed and used, and the specified PPE was used, no personnel received, or would be likely to receive a significant dose or radioactive material uptake.

Because the combustible control surveillances have been performed numerous times on this glovebox without surveillance personnel identifying any combustible material or any concern that they could not see all parts of the glovebox, there are implications that other gloveboxes could contain unacceptable quantities of combustible materials. Building management was aware of this implication and took immediate steps after this event to verify that other gloveboxes did not have unacceptable combustible materials. The results of these additional independent inspections identified minor amounts of combustibles, which were subsequently removed in some gloveboxes when judged significant. An assessment of the combustible control program was also initiated

Another implication with significance relates to crew training. Personnel are trained on what actions to take in an emergency, and especially steps to take when there are fires. In spite of this ongoing training, the crew and supervisor

involved in this incident took actions that were contrary to applicable training and potentially endangered their lives as well as others who may have provided assistance. The crew believed (incorrectly) that they were safe and felt that their training allowed them to perform the actions taken to put out what they judged to be a small fire.

Consequences: The consequences of this event to people and the facility were minor. There was no significant damage to equipment or personnel. The only thing that burned was trash; no equipment was destroyed by the fire. However, fire fighter clothing and PPE were lost due to contamination. There were no immediate or lasting impacts to personnel. Four fire fighters received skin contamination that was quickly cleaned and because of the use of respirators, they did not receive any radioactive material uptake or significant dose (maximum of 20 mrem). Bioassay analysis of other potentially affected building personnel did not show any significant personnel contamination or radioactive material uptakes.

After the restart plan was initiated and some immediate corrective actions were implemented, the work in the room was completed. The extra effort to perform the cleanup was not considered significant.

However, there have been many resources and additional costs associated with the numerous investigations. Additionally, there have been consequences to the Kaiser Hill team reputation and to DOE's confidence in the ability of Kaiser Hill to safely perform D&D activities.

- Vulnerabilities (What set the stage for the problem): 1. The work planning process was less than adequate to address the unique hazards of glovebox 8.

Discussion: The Integrated Work Control Program (IWCP) package for the D&D of glovebox 8 was a Standard Work Package (SWP). SWPs are used when the work is repetitive, hazards are well identified, and no unique or special instructions are required to perform the activity. In this case, the configuration of the glovebox was much different than was typical in that it was floor to ceiling in height (over 20 feet), had very limited visual and glove port access, and was considered to be highly contaminated. The lack of access alone should have caused this work to be performed using a Type 1 IWCP package (which is more detailed, and usually includes specific work steps), since the internal condition of the glovebox could not be readily evaluated. Had better characterization been completed, using methods specifically adapted to the special conditions present, combustibles and other materials could have been identified prior to intrusive work into the glovebox, minimizing the hazards encountered.

There is also evidence that residual chemical compounds from prior operations were present inside the glovebox. These compounds may have included sub-oxide plutonium residues, 12M nitric acid residue and calcium / calcium fluoride

materials. Also, cerium nitrate was used to decontaminate connected gloveboxes, and combustibles from that process were present as well. Also, although none of these materials have been conclusively linked to the initiation of the fire, they were not identified in the SWP or the Job Hazard Analysis (JHA) for the work, further supporting the conclusion that the work planning process was less than adequate to address the unique hazards of glovebox 8.

- Triggers (What consummated the vulnerability and converted it into an event):
1. Combustible materials were left in the glovebox and were not identified as a potential hazard. 2. Work was initiated on the glovebox with lack of understanding and knowledge of the conditions inside the glovebox.

Discussion: Although a definitive cause of the fire has yet to be determined, the actions of cutting into the glovebox (metal panels falling into the glovebox) and / or the introduction of additional airflow (through the use of the air mover) changed conditions in the glovebox. A combination of one or both of these actions, in conjunction with materials in the glovebox initiated the fire.

The presence of combustible materials in the glovebox is the one part of the formula needed to start a fire, that is, combustible material that is exposed to an ignition source.

-Exacerbation (What made the consequences as bad as they were): 1. A breakdown of communication during the event affected the response actions of the site Fire Department, impacted decisions made regarding building evacuation, and re-entry actions to the facility. 2. The amount of combustible material left in the glovebox made the fire larger.

Discussion: Initial reports of the fire were relayed through the facility CCA by the job supervisor. While the method of notification did not affect the response time of the site Fire Department, the information did contribute to a number of decisions that may not have been appropriate for the seriousness of the event. The CCA logbook and fire dispatch entries indicate that after the notification from the supervisor to the CCA, the Fire Department was on scene in room 2325 within 11 minutes. However, based on the report by the job supervisor that this was a "small" fire, and later that the fire was out, the Fire Department did not take all of their fire fighting equipment to the scene. There was a delay of reporting between 0904-0908 causing a delay between the CCA being notified and the relay of information to the Fire Department. This contributed to a delay and interpretation that this event was not serious. The BEST team had to bring additional additional items from the step off pad to the scene so that the Fire Department could effectively control the fire.

Evacuation decisions were based, at least partly, on the understanding the fire was of little threat, and was being controlled at the scene by the D&D workers. It was deemed by the CCA and the facility management team to be more of a risk

to evacuate the entire facility with the resultant congestion at the assembly area and entrance of the facility than that caused by the fire. Although all personnel were eventually evacuated from the facility, some MSTs remained on station until 22 minutes after the Fire Department determined the fire was extinguished. Although security issues involving nuclear operations were a consideration in the decision to evacuate some areas of the facility and not others, it is the team's opinion that the communication breakdown about the magnitude of the fire was the primary cause for the decision not to immediately evacuate the entire facility.

Full personnel re-entry to the facility began at about 1415. However, there had been no air sampling performed by the Occupational Safety & Industrial Hygiene (OS&IH) facility representatives at that time. During the initial response to the event, OS&IH personnel responded to the Incident Command. Because the event was thought to be of little threat, the OS&IH representatives were not engaged in response actions, although they were available. After the fire was out, the OS&IH representatives were not specifically involved in the re-entry process. It was only after some workers expressed concern about residual odor was air sampling performed. Again, because the fire was thought to be small, and posed little risk, re-entry attachments to the facility Building Emergency Response Operations (BERO) procedure were not used, which might have driven a more formalized re-entry plan, including air sampling prior to personnel re-entering the facility.

Mitigation (What kept the consequences from being worse): 1. Immediate actions by the D&D workers after identifying the smoke, at the least, allowed for timely notification by the job supervisor to the facility CCA who in turned reported the event to the Fire Department. The Fire Department responded quickly, and through the use of a thermal imaging device rapidly determined the exact location of the fire inside the glovebox. 2. BEST team response allowed for an efficient mechanism to assist the Fire Department and their equipment to room 2325. Additionally, the BEST team is credited with supplying other support functions, contributing to a timely conclusion to the event. 3. Several building personnel identified a burning odor in various locations around the facility and notified the CCA. Several personnel, including SOEs and PuSPS supervision attempted to identify the origin of the odor. 4. The supervisor or one of the RCTs turned off the air mover that was providing ventilation to glovebox 8. This action dramatically reduced the airflow through the glovebox, potentially limiting the size of the fire. 5. The size reduction tent was fire resistant and the implementation of the combustible control program was successful at minimizing combustibles around glovebox 8 and in the room. It is unlikely that the fire could have spread to the room.

Causation Summary: An analysis of the information gathered during investigation resulted in a determination of the programmatic causes of the event. This report does not describe the physical cause of the fire, which is being investigated by the RFETS Fire Department as well as a contracted fire investigator. Although

the exact cause of the fire is not currently known (pending completion of the fire investigator report), the investigation discovered several programmatic causes that would not be dependent upon the physical cause of the fire.

Inadequate combustible control surveillances may have contributed to the fire, since none of the glovebox surveillances indicated (i.e. documented) that there was a portion of the glovebox that could not be viewed during normal inspections. A weakness in the combustible control surveillance procedure or training may have contributed to this lack of detailed inspection.

The implementation of the combustible control surveillance procedures did not document that an accumulation of combustible materials was present in glovebox 8. This missed opportunity did not identify the combustible materials primarily because of the lack of windows or other methods to readily check the glovebox interior. . Nor did surveillance or inspection personnel identify that they could not see the interior of the glovebox adequately. Had it been noted that the inspection of the glovebox could not be performed as required, a corrective action would have to be taken to open the glovebox or other method to adequately inspect the glovebox interior. If the accumulation of legacy and new combustible materials had been noted, certainly some management action would have been taken to eliminate or reduce the amount of combustible materials in the box, possibly preventing, or at least, reducing the size of the fire.

Inadequate work planning was one of the primary causes for this event. The use of a Standard Work Package (SWP) instead of a more detailed Type 1 IWCP package was a potential contributor to this cause. Special and unique hazards of glovebox 8 failed to be considered. These hazards included the configuration of the glovebox, inaccessibility to the interior, both through gloves and visually due to lack of windows. Because the interior of the glovebox was difficult to access, the quantity of combustibles, and the presence of other materials, possibly including chemical and plutonium residues and other hazards were not adequately identified. Because the SWP was used in this case, the hazards were not adequately identified because of an assumption that walkdowns for SWPs were less formal and fewer disciplines need typically participate in the walkdown portion of the hazard analysis. With fewer personnel participating, some of the hazards were apparently not well identified.

The Job Hazard Analysis (JHA) was not adequate for the hazards that should have been anticipated by the planner, engineer and job supervisor; and therefore additional controls were not considered. Although there was recognition that high plutonium contamination levels were likely, and thus the use of an SSC for contamination control, the rigor required to identify and control other hazards, including combustible materials was lacking.

Had a Type 1 work package been used, additional reviews and evaluations of the work would have been performed. Additional disciplines would have been

involved in the job walkdown. A Type 1 work package would have had detailed steps included in the performance section of the work package that would have provided a formal sequence related to the cutting of the glovebox and initiation of air flow across the glovebox. Additionally, there would have been steps that described how to remove the elevator plate and associated mechanism. This would likely have caused reviewers to determine more details about the configuration of the elevator and what possible hazards lay under the elevator plate.

Combustible materials were left in the glovebox without appropriate characterization, analysis, or approval and contrary to established procedures. Although some of the combustible material were legacy material from the time when the glovebox was closed, post fire clean out revealed that some of the combustibles were more recent and were likely from decontamination activities in previously connected gloveboxes 9 and 10. The crew indicated in interviews that at one point they staged wipes used during decontamination activities in glovebox 8 prior to bag out removal. They were subsequently directed to remove these items, but it is possible that some of these items were missed and remained in the glovebox, contributing to the combustible loading. Interviews with the work crew and work planning personnel which indicated that if the amount of combustibles had been known, the sequence of work steps would have been different.

Ineffective Communication during the fire contributed to a delay in extinguishing the fire. Based on the report by the job supervisor that this was a "small" fire, and later that the fire was extinguished, the Fire Department did not take all of their fire fighting equipment to the scene. The BEST team had to bring additional items from the step off pad to the scene so that the Fire Department could effectively control the fire.

Inappropriate response to the fire put D&D workers in jeopardy and was contradictory to site procedures and training. As the fire grew, the crew took additional steps to control the fire in conflict with the Site Hands-on Fire Extinguisher training, which does not allow the use of fire extinguishers when in PremAire PPE. Actions included removing a cover, stirring the combustible materials and using up to eight fire extinguishers while in PremAire suits. Although the workers believed that their actions were within their level of training and expertise, they did not recognize the danger they were in during the event, and did not evacuate in a timely manner.

Generic Implication/Lessons Learned

1. Inadequate combustible control surveillances may have contributed to the fire, since none of the glovebox surveillances indicated (i.e. documented) that there was a portion of the glovebox that could not be viewed during normal inspections.
2. Inadequate work planning was one of the primary causes for this

event. The use of a Standard Work Package (SWP) instead of a more detailed Type 1 IWCP package was a potential contributor to this cause. Special and unique hazards of glovebox 8 failed to be considered. Although the hazard identification process for SWPs is the same as that for a Type 1 package, in this case there was an assumption that SWPs did not need the same level of review and hazards were not properly identified during the work planning process. 3. Inappropriate response to the fire put D&D workers in jeopardy and was contradictory to site procedures and training. Incident Command did not immediately evacuate the facility as required by the Emergency Response Procedure (i.e. emergency levels, fire response checklist) and as the facility has previously trained. 4. Procedural non-compliance with the Cerium Nitrate decontamination procedure contributed to the combustible loading issues in the glovebox.

24. Evaluation (by Facility Manager/Designee):

Although there was a fire in a glovebox in the building that did include radioactive material, the building's authorization basis analyzed and anticipated that fires would occur in the building. Controls were put in place to limit the quantity of combustible materials so that a large fire could not occur. This fire was not considered large because it did not result in any release outside the building or extend beyond the interior of the glovebox. The containment tent (SSC) that enclosed the glovebox did not burn because the fire did not escape the confines of the glovebox and because the tent was constructed from fire retardant materials. Because of the way the ventilation system is designed and used, and the specified PPE was used, no personnel received, or would be likely to receive a significant dose or radioactive material uptake.

The Hughes Associates Inc who performed an analysis of the cause of the fire organized the formulation of hypotheses around the fuels present and the potential ignition sources. Five fuel types have been identified based upon available evidence: 1. cerium nitrate soaked cotton towels 2. nitric acid soaked cotton towels 3. nitric acid degraded leaded gloves 4. plutonium or calcium metal encrusted with protective oxide, and 5. ordinary combustibles

Six hypotheses developed were: (1) self-heating of degraded leaded gloves, (2) thermal ignition of the leaded gloves by the pilot coupon, (3) impact ignition of degraded leaded gloves by the pilot coupon, (4) impact ignition of the degraded leaded gloves by a glovebox cutout section, (5) impact ignition of encrusted pyrophoric metal by the pilot coupon and (6) impact ignition of encrusted pyrophoric metal by a glovebox section cutout.

Based upon analysis, the rank order of likelihood of the respective scenarios is as follows: 1. Impact ignition of nitric acid degraded leaded gloves by glovebox cutout sections 2. Self-heating of nitric acid degraded leaded gloves. 3.

Plutonium or calcium metal encrusted with a protective coating by glovebox cutout 4. Thermal ignition of nitric acid degraded leaded gloves via pilot hole coupon. 5. Impact ignition of nitric acid degraded leaded gloves by pilot hole coupon 6. Plutonium or calcium metal encrusted with a protective coating by pilot hole coupon

This list notwithstanding, per NFPA 921 the cause of this fire is undetermined because more than one hypothesis has withstood the hypothesis evaluation stage.

CONCLUSIONS The origin of this fire is the debris pile at the base of GB 8 along the north wall of the glovebox. Of the 25 cause hypotheses developed, six hypotheses have withstood the hypothesis evaluation process. As such, per NFPA 921 the cause of the fire is undetermined. The "most likely" causation hypothesis is impact ignition of nitric acid degraded leaded gloves by glovebox cutout sections that fell into the area of origin as a result of cutting operations near the top of the glovebox that were ongoing at the time of the fire.

A copy of the full Fire Investigation report and a copy of the Kaiser- Hill report "Investigation into the Circumstances Surrounding the Fire in Glovebox 8, Building 371, on May 6, 2003" will be kept on file.

25. Is Further Evaluation Required?: No

26. Corrective Actions (* = Date added/revised since final report was approved.)

1. REVIEW BUILDING 371 AND 374 TO DETERMINE ANY OTHER AREAS WITH THE POSSIBILITY FOR UNDETECTED COMBUSTIBLES.

Responsibility: W. Kirby, B-371 Engineering

Target Completion Date: 07/02/2003 **Completion Date:** 07/02/2003

2. BRIEF PROJECT PLANNERS, PRC MEMBERS, AND FOREMEN ON EVENT. STRESS IMPORTANCE OF VERIFYING NO COMBUSTIBLES PRIOR TO SIZE REDUCTION ACTIVITIES.

Responsibility: s. Romano, B-371 Training Manager

Target Completion Date: 07/31/2003 **Completion Date:** 07/28/2003

3. ISSUE LESSONS-LEARNED SITE WIDE

Responsibility: H. Gilpin, B-371 ESH&Q Manager

Target Completion Date: 10/30/2003 **Completion Date:** 09/23/2003

4. CONDUCT REFRESHER TRAINING WITH IWCP PLANNERS ON PROPER CONDUCT OF WALKDOWNS.

Responsibility: S. Romano, B-371 Training Manager

Target Completion Date: 07/10/2003 **Completion Date:** 07/10/2003

5. DEVELOP AND DISTRIBUTE THROUGH FOREMEN A TOOLBOX ON PROPER RESPONSE TO IDENTIFICATION OF NEW HAZARDS DURING THE CONDUCT OF WORK ACTIVITIES. INCLUDE SPECIFIC EXAMPLES OF COMBUSTIBLES AND INDUSTRIAL HAZARDS SUCH AS GUILLOTINE DOORS.

Responsibility: R. Romano, B-371 Training Manager Manager

Target Completion Date: 07/22/2003 **Completion Date:** 07/22/2003

6. PERFORM MANAGEMENT DIRECTED SELF ASSESSMENT OF AC 5.4 IMPLEMENTATION.

Responsibility: M. Simmons, B-371 Quality Assurance

Target Completion Date: 09/30/2003 **Completion Date:** 08/28/2003

7. REVIEW COMBUSTIBLE CONTROL PROGRAM PROCEDURES AND CLARIFY REQUIREMENTS FOR GLOVEBOX INSPECTIONS

Responsibility: D. Coyne, B-371 Maintenance Manager

Target Completion Date: 10/30/2003 **Completion Date:** 09/11/2003

8. REVISE SITE TRAINING TO CLARIFY MANAGEMENT EXPECTATIONS ON APPROPRIATE FIRE-FIGHTING

Responsibility: B. Campbell, KHLL Fire Protection Engineering

Target Completion Date: 09/15/2003 **Completion Date:** 08/25/2003

9. ISSUE SITE-WIDE TOOLBOX ON FIRE EXTINGUISHER USE AND WHEN TO FIGHT A FIRE

Responsibility: B. Campbell, KHLL Fire Protection Engineering

Target Completion Date: 07/30/2003 **Completion Date:** 06/30/2003

10. ISSUE SITE-WIDE TOOLBOX ON EMERGENCY NOTIFICATION PROTOCOL. STRESS IMPORTANCE OF CALLING X2911 IN EVENT OF FIRE.

Responsibility: B. Campbell, KHLL Fire Protection Engineering

Target Completion Date: 07/30/2003 **Completion Date:** 06/30/2003

11. REVIEW BUILDING 371 EMERGENCY RESPONSE PROCEDURES FOR ADEQUACY AND UPDATE AS REQUIRED

Responsibility: D. Thistlewood, B-371 Facility Manager

Target Completion Date: 07/02/2003 **Completion Date:** 07/02/2003

12. BRIEF CCAS AND BUILDING EMERGENCY RESPONDERS ON EMERGENCY RESPONSE PROCEDURES, WITH SPECIAL EMPHASIS ON EVACUATION PROCESS.

Responsibility: D. Thistlewood, B-371 Facility Manager

Target Completion Date: 07/11/2003 **Completion Date:** 07/11/2003

13. REVIEW SITE EMERGENCY RESPONSE PROTOCOL. REVISE IF NECESSARY.

Responsibility: R. Kopplin, KHLL SITE Emergency Planning

Target Completion Date: 07/30/2003 **Completion Date:** 07/30/2003

14. PROVIDE REFRESHER TRAINING TO CCAS ON COMMUNICATION RESPONSIBILITIES FOR THE INCIDENT COMMAND.

Responsibility: D. Thistlewood, B-371 Facility Manager

Target Completion Date: 07/11/2003 **Completion Date:** 07/11/2003

15. EVALUATE THE USE OF SWPS VS. TYPE 1 IWCP PACKAGES FOR D&D WORK WITHIN THE FACILITY. EVALUATE CURRENT SWP AND IWCP PACKAGES IN USE IN THE FACILITY TO ASSURE ADEQUATE HAZARD IDENTIFICATION HAS BEEN COMPLETED, INCLUDING ADEQUACY OF JHAS.

Responsibility: W. Kirby, B-371 Engineering Manager

Target Completion Date: 11/14/2003 **Completion Date:** 10/15/2003

16. CLARIFY SUPPORT ORGANIZATION (OS&IH, RADIOLOGICAL PROTECTION, ETC.) RESPONSIBILITIES DURING EVENTS THAT REQUIRE FACILITY INCIDENT COMMAND TEAM RESPONSE.

Responsibility: D. Thistlewood, B-371 Facility Manager

Target Completion Date: 11/30/2003 **Completion Date:** 10/15/2003

17. EVALUATE REVISION TO PROCEDURE PRO-V58-BERO-14.371/374, BUILDING 371/374 EMERGENCY RESPONSE OPERATIONS TO INCLUDE AN ATTACHMENT FOR FACILITY RE-ENTRY AFTER EVENTS THAT DO NOT RISE TO THE LEVEL OF "EMERGENCY."

Responsibility: D. Thistlewood, B-371 Facility Manager

Target Completion Date: 07/02/2003 **Completion Date:** 07/02/2003

18. COMMUNICATE FACILITY MANagements' EXPECTATION OF PROCEDURAL COMPLIANCE TO WORKERS AND THEIR SUPERVISION THROUGH TOOLBOX SAFETY MEETINGS, ALL-HANDS BRIEFINGS AND PRE-EVOLUTION BRIEFINGS.

Responsibility: K Trice, B-371 Project Manager

Target Completion Date: 11/11/2003 **Completion Date:** 11/05/2003

19. VERIFY THE CORRECTIVE ACTION IS EFFECTIVE BY CONDUCTING ADDITIONAL SELF-ASSESSMENTS FOCUSING ON PROCEDURAL COMPLIANCE DURING WORK ACTIVITIES.

Responsibility: M. Simmons, B-371 Assessments

Target Completion Date: 04/30/2004 **Completion Date:** 04/30/2004

20. PROCEDURE PRO-1470-DECON-371/374, CHEMICAL DECONTAMINATION OF EQUIPMENT OR GLOVEBOXES CONTAMINATED

WITH PLUTONIUM AND PRO-1638-FIRE CTRL-371, BUILDING 371/374 COMBUSTIBLE CONTROL WERE REVISED TO INCORPORATE ADDITIONAL CONTROLS FOR THE USE OF CERIUM NITRATE SOLUTIONS AND THE VERIFICATION THAT UN-NEUTRALIZED CERIUM NITRATE SOAKED MATERIALS ARE NOT LEFT UNATTENDED.

Responsibility: H. Gilpin, B-371 ESH&Q Manager

Target Completion Date: 08/20/2003 **Completion Date:** 08/20/2003

21. NUCLEAR SAFETY TO EVALUATE THE FIRE TO DETERMINE IF THE EVENT WAS BOUNDED BY THE SAFETY BASIS.

Responsibility: H. Gilpin, B-371 ESH&Q Manager

Target Completion Date: 05/28/2003 **Completion Date:** 05/28/2003

22. CONDUCT ALL HANDS MEETING HELD WITH FACILITY PERSONNEL TO DISCUSS THE EVENT AND THE RESPONSE/EVACUATION THAT SHOULD HAVE BEEN TAKEN.

Responsibility: K Trice, B-371 Project Manager

Target Completion Date: 05/07/2003 **Completion Date:** 05/07/2003

27. Impact on Environment, Safety and Health:

There was no significant damage to equipment or personnel. The only thing that burned was trash; no equipment was destroyed by the fire. However, fire fighter clothing and PPE were lost due to contamination. There were no immediate or lasting impacts to personnel. Four fire fighters received skin contamination that was quickly cleaned and because of the use of respirators, they did not receive any radioactive material uptake or significant dose (maximum of 20 mrem). Bioassay analysis of other potentially affected building personnel did not show any significant personnel contamination or radioactive material uptakes.

28. Programmatic Impact:

No programmatic impact occurred. There was no loss of data, schedule delays resulting from this incident.

29. Impact on Codes and Standards:

This occurrence did not have an impact on national codes, standards, program standards or DOE Orders.

30. Lessons Learned:

Although the ignition source is still uncertain, it is clear that the fire could have been avoided had the glovebox not contained an unacceptable accumulation of combustibles. Building 371 personnel could have done a better job of planning for this glovebox. Glovebox 8 was unique and presented unusual D&D

challenges. Among the planning improvements include doing a better job of checking out the inside of the glovebox before work begins.

The preliminary findings also address the D&D workers' response to the fire. Although their attempt to extinguish the fire helped contain the flames to the glovebox and prevent the fire from spreading, the workers put themselves at risk. Any fire should be immediately reported to the Fire Department by using a fire phone, manual pull station or by calling 2911. Then notify supervision and the building CCA. Workers who are trained in using fire extinguishers may attempt to extinguish small fires if they don't feel that they are in danger. But if the initial attempt isn't immediately successful after using one or two extinguishers, stop and safely evacuate the area. The Fire Protection Program recently mailed fire extinguisher brochures to all site personnel reinforcing the requirement to use only one or two extinguishers.

Specific Lessons Learned

1. Inadequate combustible control surveillances may have contributed to the fire, since none of the glovebox surveillances indicated (i.e. documented) that there was a portion of the glovebox that could not be viewed during normal inspections. Lesson - when a procedure cannot be performed as written or the procedure or attachments do not provide the necessary information to cover the situation, stop and ask your supervisor or appropriate manager for guidance. The procedure used to document the inspections of gloveboxes had a simple satisfactory/unsatisfactory check block and did not allow for documenting unusual situations, like the lack of viewing access to Glovebox 8.

2. Inadequate work planning was one of the primary causes for this event. The use of a Standard Work Package (SWP) instead of a more detailed Type 1 IWCP package was a potential contributor to this cause. Special and unique hazards of glovebox 8 failed to be considered. Although the hazard identification process for SWPs is the same as that for a Type 1 package, in this case there was an assumption that SWPs did not need the same level of review and hazards were not properly identified during the work planning process. Work package review walkdowns were not done with the appropriate number and discipline of personnel because of inappropriate assumptions. Lesson - don't make assumption that are not based on requirements or guidance provided in applicable procedures. Don't assume that because a work package is not Type 1 that the hazards are standard or minimal. 3. Inappropriate response to the fire put D&D workers in jeopardy and was contradictory to site procedures and training. Lesson - don't get caught up in the moment, try to remember your training and emergency response requirements. Don't assume you know the situation well enough that you can disregard your training. In this case, the workers felt they were in no danger from this small smoldering fire and that by using a couple fire extinguishers they were helping others. In fact, they put themselves and others in more jeopardy because they felt compelled to keep

fighting the fire once they started. This attitude could have caused them to become involved in a situation they could not safely extricate themselves from and required others to put themselves in harms way to rescue them, if they could. 4. Minor procedural non-compliances contributed to the combustible loading issues in the glovebox. Lesson - even apparently minor noncompliances that if allowed to continue over time can lead to big events. In this case, some minor amount of combustible material was left in the glovebox, accumulating a little at a time for years. There has been a requirement for not leaving combustibles or for cleaning up combustible materials for a long time. Compounding these minor accumulations were the procedure inadequacies and noncompliances related to inadequate surveillances for combustibles. These noncompliances led to the unacceptable accumulation of materials that contributed to the fire and/or size of the fire.

31. Similar Occurrence Report Numbers:

ALO-KO-SNL-1000-2001-0001 CH-AA-ANLE-ANLEPFS-2001-0013 RL--PNNL-PNNLBOPER-2001-0005 RL--PNNL-PNNLBOPER-2002-0001

32. User-defined Field #1:

030097 ISM=GP1-CF1

33. User-defined Field #2:

08/28/2003 10/30/2003 6/30/2004

34. HQ Keyword(s):

01P--Conduct of Operations - Safety System Actuation (Start Nov 97) 03C--Fire Protection Systems - Fire Suppression Actuation 03D--Fire Protection Systems - Fire/Explosion 06C--Radiological Issues - Skin Contamination 11A--Other - Chemical Reaction/Pressurized Drum 12F--EH Categories - Fire Protection 13F--Management Concerns - Operating Experience Summary Article

35. HQ Summary:

36. DOE Facility Representative Input:

None.

Entered by: PARKIN, JEFFRY M Date: 05/20/2004

37. DOE Program Manager Input:

Approved by Terry Krietz for Patty Bubar per memorandum dated December 16, 2004

Entered by: MCMILLAN, JEFFREY T Date: 12/16/2004

38. Approvals:

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